



GOAL 8: Sound Science

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GOAL 8: SOUND SCIENCE, IMPROVED UNDERSTANDING OF ENVIRONMENTAL RISK, AND GREATER INNOVATION TO ADDRESS ENVIRONMENTAL PROBLEMS

EPA will develop and apply the best available science for addressing current and future environmental hazards, as well as new approaches toward improving environmental protection.

OVERVIEW

As stated in its Strategic Plan, EPA strives to ensure that “national efforts to reduce environmental risk are based on the best available scientific information.” Sound science enables EPA to identify the most important sources of risk to public health and the environment and thereby guide its policies and resource allocation. As EPA addresses increasingly complex issues in the future, its research programs will continue to provide the understanding and technologies needed to detect, abate, and avoid public health and environmental problems. Evaluating options for mitigating environmental risks also requires economic analysis tools for assessing the benefits and costs of environmental protection.

Building on its scientific, economic, and regulatory research and analysis activities, EPA strives to make environmental protection more flexible, efficient, and effective. The Agency’s efforts include streamlining core regulatory programs through a reduction in unnecessary monitoring and reporting requirements and designing and testing fundamentally new approaches with multimedia, industry-, or place-based focuses.

In its Strategic Plan, EPA established nine objectives to guide its innovative, science-based work toward this multi-faceted and mission-critical goal:

- By 2008, provide scientific understanding to measure, model, maintain, or restore ecosystems.
- By 2008, improve the scientific basis to identify characterize, assess, and manage environmental exposures that pose the greatest risks to the public.

- By 2008, establish capability and mechanisms to anticipate and identify environmental or other changes that might portend future risk and integrate futures methods into planning.
- By 2006, develop and verify improved tools, methodologies, and technologies for addressing high-priority human health and environmental problems.
- By 2005, increase the number of places using integrated, holistic partnership approaches and quantify the benefits.
- By 2005, increase the number of and opportunities for sector-based approaches.
- By 2005, enhance the capability of EPA’s Regional offices to assess environmental conditions.
- Conduct peer review and provide guidance on science underlying Agency decisions.
- Incorporate innovative approaches to environmental management throughout Agency programs.

FY 1999 PERFORMANCE

Understanding Ecosystems

By 2008, the Agency’s objective is to provide the scientific understanding to measure, model, maintain, or restore, at multiple scales the integrity and sustainability of ecosystems now and in the future. The Agency has four primary areas of emphasis within this objective: (1) improve environmental monitoring in order to measure the relative success of environmental policies; (2) develop the next generation of environmental modeling systems to assist local and Regional managers in evaluating

alternative environmental management policies; (3) continue the advancement of the environmental assessment sciences in order to provide the information needed by decision-makers to choose the best alternatives; and (4) conduct restoration experiments to provide solutions within an adaptive management process.

In FY 1999, EPA researchers completed the first stage of the Environmental Monitoring and Assessment Program (EMAP) effort in support of the Agency's FY 2001 commitment to complete and evaluate a multi-tiered ecological monitoring system for the Mid-Atlantic Region and provide select land cover and aquatic indicators for measuring status and trends (APG 50). As a result of completing the first stage of this effort, EPA proved that it can cost-effectively monitor the condition of ecosystems at a regional scale. The data collected to date form the foundation for assessing the overall condition of the Mid-Atlantic Region and move the Agency toward completion of this effort as planned by FY 2001. Equally as important, the lessons learned

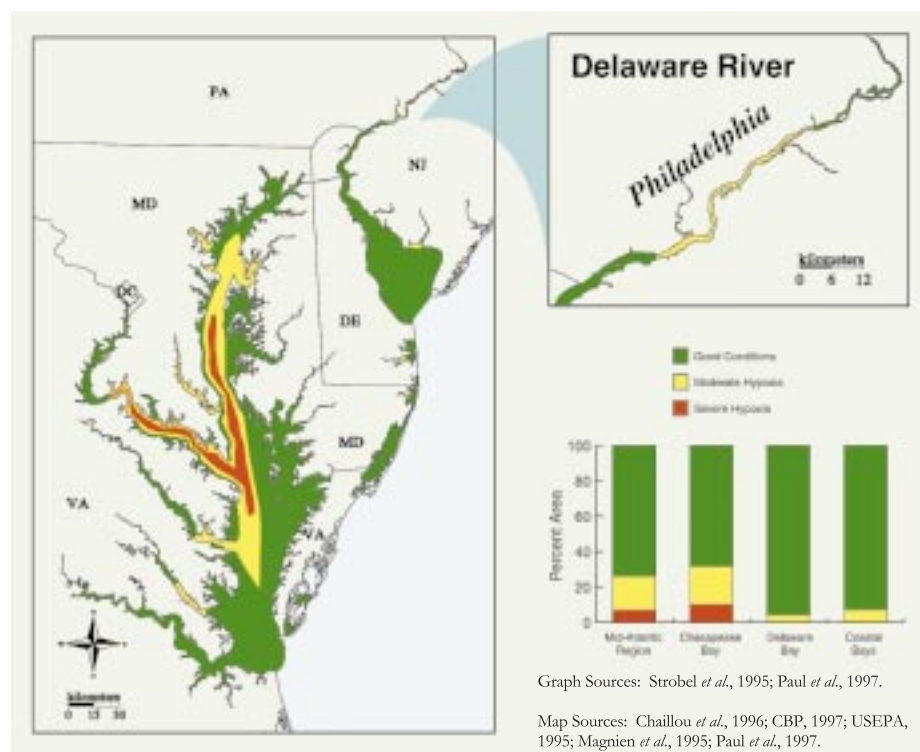
in designing the monitoring program can be applied nationwide, allowing other Regions to measure current environmental conditions and monitor ecosystem changes in a consistent manner.

EPA performed several prototype analyses addressing sulfur and nitrogen wet and dry deposition trends to meet the Agency's FY 1999 commitment to analyze existing monitoring data for acid deposition (APG 51). In one study, EPA researchers analyzed data on 205 monitored lakes and streams in five different geographic regions. The analysis indicated that lakes and streams in certain regions of North America and Europe show some signs of recovery from acid rain. The results to date show significant declines in the levels of sulfate, while at the same time, only a few regions demonstrated even a modest decline in levels of nitrate, another acid rain component. The next step in the analysis will be to compare the trends in air quality and deposition chemistry to trends in surface water quality. EPA will incorporate the results from this and other analyses into a formal report on acid rain to be

released in 2002. Chapter 6 of this report provides information on the status of UVB (ultraviolet radiation-B) monitoring efforts related to this acid deposition research.

EPA met another FY 1999 goal by providing ecological risk assessment case studies for two watersheds, final guidelines for reporting ecological risk assessment, and ecological risk assessment guidance and support (APG 52). Ecological risk assessment case study reports for two watersheds, the Middle Snake in Idaho and Clinch Valley in Virginia and Tennessee, are now complete. Since releasing its ecological risk assessment guidelines one year ahead of schedule in 1998, EPA also has conducted numerous ecological risk assessment training sessions to

Dissolved Oxygen Conditions in the Mid-Atlantic Region



Distribution of summertime dissolved oxygen within one meter of bottom sediments across estuaries in the Mid-Atlantic Region. Conditions of low levels of dissolved oxygen can harm bottom-dwelling organisms and are most widespread in the middle portions of Chesapeake Bay and the lower Potomac River.

encourage the use and further refinement of the guidelines. Two FY 1999 workshops focused on refining the process for ecological risk characterization at the watershed scale and conducting the first phase of the ecological risk assessment process for regional-scale assessments.

Also in FY 1999, EPA began several projects in ecosystem restoration with special emphasis on the restoration of stream banks, or riparian zones, considered by ecologists to be one of the most important habitats. EPA Headquarters is working with its Region 3 office and the State of Maryland on these projects and will continue to provide reliable information on alternative restoration approaches.

Understanding the Greatest Environmental Risks to Human Health

EPA has committed, by 2008, to improve the scientific basis used to identify, characterize, assess, and manage environmental exposures that pose the greatest health risks to the American public. This requires research, model development, and other data collection efforts to reduce significant areas of uncertainty. Reduced uncertainty will enable the Agency to more accurately assess health risks associated with exposure to environmental pollutants, ultimately leading to more effective implementation of EPA's regulatory mandates under the Federal Insecticide, Fungicide, and Rodenticide Act, the Toxic Substances Control Act, the Food Quality Protection Act, and other environmental legislation.

In FY 1999, the Agency met its goal to produce a first generation model that can be used in a prospective context to provide reliable assessments of the potential risks to human populations posed by exposure to pesticides and other toxic chemicals (APG 53). The Agency also initiated eight studies on childhood exposure to pollutants. The resulting data and methods will add to an existing body of tools and knowledge critical to EPA's ability to conduct risk assessments and implement sound environmental policy.

The Agency also made significant progress in FY 1999 toward meeting its long-term goal of developing and verifying innovative methods and

models for assessing the susceptibilities of populations to environmental agents (APG 54). During FY 1999, EPA awarded seven new grants on a variety of topics related to children's risk from environmental pollutants, including childhood cancer, the neuro-behavioral effects of air pollutants, children's exposure to pesticides, and the effects of neonatal exposure to naphthalene. The results of these studies, which will be available by 2003, will assess children's susceptibility through a multidisciplinary evaluation of age-related differences in exposure and toxicity. These results will move the Agency toward achievement of its long-term goal as planned by FY 2008.

Detecting Emerging Risks

In addition to addressing existing risks, EPA has committed that by 2008, it will be able to anticipate and identify environmental or other changes that may indicate future risk, integrate futures planning into ongoing programs, and promote coordinated preparation for and response to change. By increasing its capacity to look toward emerging risks, EPA will be able to identify the data needs and develop the required analytic approaches to reduce risks before they affect human health or the environment.

An important aspect of this objective is research into endocrine disrupting chemicals (EDCs). Evidence continues to build that humans as well as domestic and wildlife species may suffer adverse health effects from exposure to EDCs. *EPA achieved its FY 1999 goal to complete a protocol for a field study of children exposed to two EDCs (APG 55).* This study will produce high-quality data characterizing the key factors that influence human exposures to EDCs and other persistent pesticides, toxics, and metals. The data resulting from this and other follow-on studies will help refine human exposure models and provide insights into where, when, and how children and other sensitive sub-populations are exposed to these environmental contaminants. EPA's EDC research program also provided standardized protocols for mammalian assays to monitor endocrine activity. The Agency completed protocols to assess pubertal development and thyroid function in immature (23-53 day old) male rats and pubertal development and thyroid

function in juvenile female rats. EPA needs these protocols to successfully implement provisions of the Food Quality Protection Act.

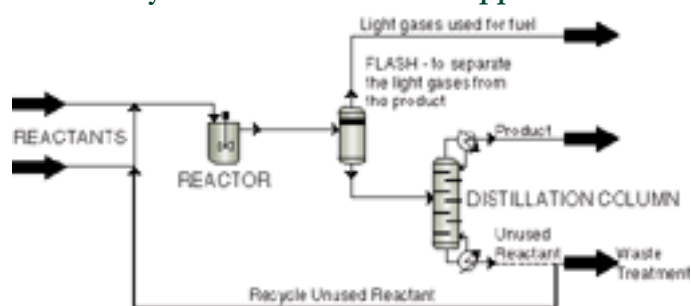
In addition to the developments in risk assessment data, the quality and consistency of the economic information and methods available to EPA have improved due to activities completed in FY 1999. First, EPA updated and released guidelines on preparing economic analyses to consider in the development of regulations. Second, the Agency convened the first of three workshops in an ongoing economic research and policy series, bringing together economists to explore important questions, including the valuation of ecological effects and childhood health effects. Also, the National Science Foundation and EPA implemented a newly prepared research plan focusing on the Agency's priorities for environmental economics when soliciting joint economic research proposals. Finally, EPA and other Federal agencies made a major commitment to improve the quality and completeness of future economic analyses by renewing a national survey of pollution expenditures within the U.S. manufacturing sector.

Understanding How to Prevent Pollution and Design New Environmental Protection Technologies

Recognizing the importance of prevention, EPA's objective is that by 2006, it will develop and verify improved tools, methodologies, and technologies for modeling, measuring, characterizing, preventing, controlling, and cleaning up contaminants associated with high-priority human health and environmental problems. EPA supports pollution prevention (P2) as a necessary and logical strategy for dealing with high-risk human health and environmental problems. EPA researchers are focusing on the design and development of user-friendly, quantitative P2 tools. The Agency is also developing and verifying new technologies (NT) that are preventive in nature.

EPA research in the area of pollution prevention uses multiple tools and methodologies that provide quantitative information for selecting preferred pollution prevention options. The Waste Reduction (WAR) Algorithm uses process information to

Using the Waste Reduction (WAR) Algorithm to Identify Pollution Prevention Opportunities



evaluate the environmental friendliness of a process design and to identify areas for pollution prevention, as shown in the simplified process flow diagram above.

In FY 1999, EPA made significant progress in a number of areas toward achieving its P2/NT objective. The Agency's Environmental Technology Verification (ETV) Program verified 53 technologies as meeting pollution prevention and related claims. EPA also completed a series of research efforts on preventing the formation of volatile organic compounds (VOCs). To make these research results available to stakeholders, the Agency updated the Coating Alternatives Guide (CAGE) and placed it on the Internet. EPA also completed an inventory of tools that will guide further P2/NT development by focusing on the needs of community decision-makers.

Peer-reviewed extramural research conducted under the Agency's Science to Achieve Results (STAR) grants program also supports EPA's objective for developing pollution prevention and other innovative approaches. In FY 1999, EPA concentrated on two research areas that support preventive approaches for human health and environmental protection: Technology for a Sustainable Environment (TSE) and economic valuation. Under TSE, research took place on the use of carbon dioxide to replace toxic chemical solvents in painting and other coating processes and in plastics production. In addition, research on economic valuation produced improved survey techniques for determining how the public values ecological resources, such as clean, fishable lakes and rivers.

Finally, through its participation in the Federal interagency High Performance Computing and Communications program, the Agency continued work developing an innovative model design and community-oriented computing approach for investigating large-scale, complex environmental problems. A major part of this effort is further development of the Multimedia Integrated Modeling System (MIMS) through peer review and demonstration of its first component, the community multi-scale air quality model for particulate matter (PM). *EPA finished work on the air component of the MIMS and met its FY 1999 goal of improving computational efficiency in the analysis of PM by 25 percent (APG 56).* EPA expects that the increased computational efficiency resulting from this work will enable State agencies and other regulators to perform an adequate number of model simulations for PM assessment and air quality policy purposes.

Quantifying Tangible Results of Integrated Partnerships

As part of a continued focus on innovative approaches, by 2005 EPA's objective is to increase partnership-based projects with counties, cities, States, Tribes, resource conservation districts, and/or bio-regions and bring together needed external and internal stakeholders to effect positive environmental change with a focus on multimedia results.

In FY 1999, EPA issued its Framework for Community-Based Environmental Protection, which provides the tools for integrating this approach across the Agency's program areas. The Framework also documents the benefits of these innovative partnerships. In FY 1999, EPA supported 99 such

projects through its Regional Geographic Initiative (RGI). Of the 99 projects, 35 foster partnerships in new areas. All of the RGI projects support either important Administration or Agency initiatives and contribute to the achievement of other Agency long-term goals. For example, Region 1's project on Smart Growth in New England supports both air and water goals in developing tools and approaches for communities to use in combating sprawl and encouraging development that makes economic, environmental, and social sense. Region 7's Omaha project supports many goals by implementing community-based projects to address illegal dumping, lead poisoning, and other environmental issues of most concern to the city.

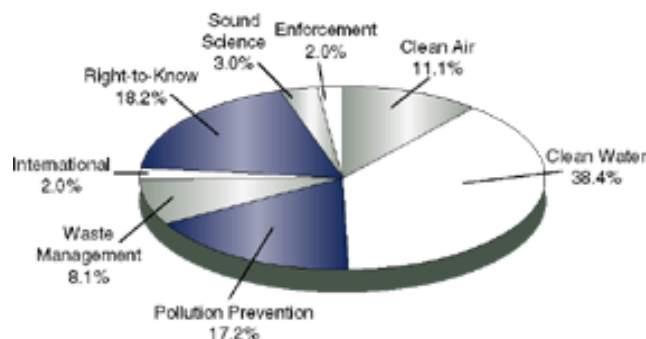
Improvements Through Testing Sector- and Facility-Based Innovations

By 2005, EPA's objective is to test increasing numbers of innovative facility- and sector-based strategies to achieve improved environmental protection and make successful approaches broadly available. EPA works toward this objective through Project XL and the Agency's sector-based programs growing out of the Common Sense Initiative (CSI), joining with private and public sector organizations to test innovative strategies that produce superior environmental results.

XL projects are undertaken by private or public sector organizations under agreements with EPA. In FY 1999, EPA signed five new XL Agreements, bringing the number of projects in the implementation stage to 15. As of FY 1999, an additional 36 XL proposals *were either under development or in negotiations, meeting EPA's FY 1999 commitment to have 50 XL projects under implementation or in development or negotiation (APG 57).*

Also in FY 1999, EPA and its partners determined that 30 innovations resulting from XL projects have the potential to improve traditional regulatory programs. Overall, EPA has found that XL projects produce greater reductions in environmental releases than would have occurred under conventional regulatory approaches. At the same time, XL project participants reduce environmental management costs and improve their

Distribution of Regional Geographic Initiative (RGI) Projects Across Agency Goals



competitiveness as a result of expedited or consolidated permitting, reduced record-keeping and reporting requirements, and greater operational flexibility afforded by facility-wide emission caps.

Similarly, EPA's sector programs sought "cleaner, cheaper, and smarter" approaches to environmental protection through sector-based, multi-stakeholder initiatives that rely on consensus-building processes. Some innovations tested through CSI projects have already resulted in regulatory changes. For example, the CSI Iron and Steel Sector project found that changes in electric arc furnace operations allow improved monitoring of PM emissions through use of more flexible emission control system procedures. In FY 1999, EPA promulgated a final air emissions rule incorporating these procedures. Other outcomes of sector-based efforts include the following:

- The metal finishing sector developed and launched an industry sector performance-based environmental stewardship program with voluntary "better than compliance" facility performance targets and a comprehensive stakeholder-backed action plan to provide incentives, create tools, and remove barriers to the accomplishment of these targets. More than 350 companies, 19 States, and 60 local governments are participating in this program and achieving environmental results as high as a 93 percent reduction in water use, 77 percent reduction in energy use, 99 percent reduction in organic chemical usage, and 73 percent reduction in metals emissions.
- EPA has begun to incorporate sector-based environmental management approaches into its core regulatory programs. For example, the Agency has identified several sectors for potential multimedia coordination within rule-making efforts in FY 2000, such as mercury cell chloralkali plants and publicly-owned treatment works (POTWs). EPA also is exploring the development of sector-based permit reform models as a means of expanding the application of innovative new permit approaches.
- Through the Sustainable Industry process, EPA is working with several industry sectors to

develop incentives, remove barriers, and create tools to improve environmental performance while lowering regulatory burdens. Some of these sector-specific activities may lead to the creation of voluntary industry stewardship programs similar to the metal finishing program described above, with performance track incentives and rewards built in. Other sectors will pursue innovative reform ideas on a less expansive scale. Current Sustainable Industry sectors include metal casting and foundries, meat processing, specialty-batch chemical manufacturing, and shipbuilding.

- The Atlantic Steel XL project in Atlanta demonstrates EPA's efforts to provide regulatory flexibility and foster livable communities. This project is designed to remediate and develop property that for over a century was an industrial steel mill. When complete, the project will turn a Brownfield site into new neighborhood amenities and housing opportunities in the city, reduce storm water runoff, save open space, bring stores closer to work and schools closer to homes, and reduce vehicular travel by more than 50 million miles a year.

Providing Validated Data to Enable Accurate Environmental Decision-Making

By 2005, EPA's objective is that its Regional offices will have demonstrated capability to assess environmental conditions within their jurisdictions, compare the relative risk of health and ecological problems, and assess the environmental effectiveness of management action in priority geographic areas. This objective is geared toward providing field sampling, analytical and data management support, and quality assurance to Agency programs.

To meet this objective, EPA has established Centers of Applied Science to develop sampling, quality assurance, and analytical methods to support assessment of environmental issues. The Centers will facilitate the development and application of new and innovative technologies, such as alternative methods for trace level dioxin/furan analyses and new methods for the identification and quantification of microbial contaminants, such as *Cryptosporidium*. EPA will put information

management systems in place to enable itself and partner agencies to locate, assess, and share environmental data and analytical methods. These efforts will continue to build EPA capacity, as well as that of partner agencies, by providing technical and analytical support in the assessment of environmental problems and by helping to convert environmental data into useful information for decision-making. In FY 1999, Centers of Applied Science were established in the following areas: ambient air monitoring; environmental biology; environmental chemistry; environmental microbiology; and analytical pollution prevention methodologies.

Science Advisory Board Guidance that Improves the Production and Use of Science at EPA

EPA seeks to ensure the quality and relevance of all of its scientific and technical information. To accomplish this aim, EPA's Science Advisory Board (SAB) conducts peer reviews and provides guidance on the science underlying Agency decisions. The SAB is a legislatively mandated group of non-governmental scientists, engineers, and economists charged with providing independent technical advice on environmental issues to EPA's Administrator and others (e.g., Congressional committees). The SAB conducts its business in public meetings and benefits from public input during its deliberations. Through these proceedings, Agency positions are subjected to critical examination by leading experts in the field in order to test the currency and technical merit of those positions. In FY 1999, the SAB held 48 meetings and produced 38 reports (<http://www.epa.gov/sab/fiscal99.htm>).

Among the activities that were particularly important to the Agency and the way that it does business are the peer reviews of the following: guidelines for preparing economic analyses, fine particle monitoring methodologies, the use of human data in decision-making, the guidelines for cancer risk assessment, and the FY 2000 Presidential Science and Technology Budget Request.

Incorporating Innovative Approaches into EPA Programs

One of the most important aspects of EPA's reinvention program is the use of innovative approaches to help industry and the regulated community improve environmental performance and secure compliance with environmental laws. EPA's objective is to incorporate innovative approaches in environmental management throughout its programs so that the Agency and its external partners achieve greater and more cost-effective public health and environmental protection.

The Agency believes a system that promotes stewardship, in addition to compliance with environmental requirements, has the greatest potential for advancing environmental management capabilities and solving environmental problems. In January 1999, the Administrator established the Innovations Task Force, bringing together experts and stakeholders from inside and outside the Agency to share their views on the next steps for reinvention activities. The Task Force issued a report that describes ten strategic actions the Agency will take in the next 12 to 18 months to motivate superior environmental performance and aid environmental compliance where needed (<http://www.epa.gov/ooaujeag/taskforce/report99>). Creating a system where everyone takes more responsibility for protecting the environment requires some changes. The Agency is committed to a number of actions to help accelerate environmental progress:

- Using incentives to encourage action beyond requirements and promoting environmental management systems (EMSs) that help organizations incorporate environmental considerations into business operations.
- Developing a "performance track" that identifies and rewards environmental leaders; working with the States, Tribes, industry, and environmental and other interest groups to define what it means to be a top environmental performer; and identifying appropriate building blocks to enhance the current regulatory system.

- Providing timely and accessible compliance assistance by becoming a more effective "whole-saler" of compliance assistance information; providing tools, assistance, and resources needed to comply with the requirements as the rules take effect; and using compliance assistance in strategic combination with enforcement, monitoring, and incentives to achieve environmental results.
- Creating flexible and streamlined permitting by working with the States to make the permit system more effective at meeting environmental goals without creating unnecessary social and economic burdens; and moving permitting toward measuring performance while providing regulated parties more flexibility in how standards are met.
- Helping communities make sound environmental decisions by developing new environmental management tools, offering technical assistance, providing facilitation support for dialogue on environmental issues, and consulting with stakeholder representatives before making Agency decisions about programs or policies that directly affect them.

PROGRAM EVALUATION

EPA engaged in many efforts in FY 1999 to evaluate the quality and relevance of its research programs. First, research proposals received in response to Requests for Applications underwent rigorous external peer review. Second, the EPA Board of Scientific Counselors evaluated the Agency's science and engineering research programs, laboratories, and research management practices and recommended actions to improve their quality and relevance to the mission of EPA. In addition, the Board evaluated and provided advice concerning the utilization of peer review within Agency research programs to enhance the quality of science at EPA.

An independent third-party review of the four-year Common Sense Initiative (CSI) effort was conducted in FY 1999 to assess the extent to which CSI succeeded in meeting its goals and to determine what was gained from the sector-based, multi-stakeholder, and consensus aspects of the Initiative.

The study concluded that CSI was extremely productive in terms of projects developed and recommendations submitted to the Agency for action. The study also showed that the pace of development of CSI's recommendations and project implementation increased over that reported in a earlier evaluation (<http://www.epa.gov/sectors/csi.htm>).

CONCLUSIONS AND CHALLENGES

EPA continues to work toward its long-term commitment of developing and applying sound science and innovative approaches to environmental protection. Sound science enables EPA to identify the most important sources of risk to public health and the environment and thereby guide its policies and resource allocation. As EPA strives to pioneer and utilize the best available science to understand and address environmental hazards, the Agency faces the additional challenge of communicating scientific and engineering accomplishments to properly represent their role in the achievement of the overall environmental protection mission.

Evaluating options for mitigating environmental risks also requires economic analysis tools for assessing the benefits and costs of environmental protection. The state of environmental science and technology is rapidly changing, such that what is cutting-edge this year may no longer be so next year. For this reason, Agency scientists and engineers continue to pursue new avenues of research in order to understand current environmental problems and foresee those on the horizon.

KEY MILESTONES FOR THE FUTURE

- EPA researchers will use the work completed in FY 1999 under the Environmental Monitoring and Assessment Program (EMPACT) to produce a report in FY 2000 on monitoring findings in the Mid-Atlantic Region as a cost-effective means of measuring ecosystem conditions. This report will move EPA toward the FY 2001 completion and evaluation of a multi-tiered ecological monitoring system for the Mid-Atlantic Region.
- In FY 2001, EPA will provide land cover and aquatic indicators for measuring ecosystem condition and trends. This work will establish a

baseline for documenting changes in the ecological condition of the nation's ecosystems and results of regional-scale environmental management policies.

- Studies of organophosphates, trazines, and pyrethroids funded through EPA research grants produced a series of papers in FY 1999 summarizing the methodologies used and preliminary data analyses. The results of these studies will facilitate individual FY 2000 assessments of children's exposure to pesticides in Washington, Minnesota, and Arizona. In FY 2000, the Agency will award additional research grants to facilitate development of an integrated exposure assessment of children in three regions of the United States.
- In FY 2000, efforts to prevent or reduce pollution will focus on completing development of more computer-based tools to simulate product, process, or system design changes and will complete demonstrations of one or more generic technologies for chemical and industrial processes. By as early as FY 2001, EPA will develop, evaluate, and deliver technologies and approaches that eliminate, minimize, or control high risk pollutants from multiple sectors. This work will benefit industries and communities having difficulty meeting control, emission, or effluent standards.

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